Slight Bronchopneumonia in A Centenarian Diagnosed by Chest CT Scan with Maximum Intensity Projection (MIP)

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Abstract

The current case is a 102-year-old female centenarian with slight bronchopneumonia. She did not have any remarkable health or medical problems until 2022. In May 2023, she developed a cough and fever and underwent a lung CT scan, which revealed a consolidation shadow in the left posterior middle lung. This image was created with a 1mm width for each 1mm interval. Additionally, a further image was generated using maximum intensity projection (MIP) with a 3mm width for a slab thickness of 20mm. Based on this data, a diagnosis of slight bronchopneumonia in the left lung was made. She was treated with levofloxacin 500mg/day for 5 days, which led to clinical improvement.

Abbreviations

MIP: Maximum Intensity Projection

Introduction

Recent advances in medical imaging have led to the use of deep learning (DL) techniques for diagnosing lung diseases, such as lung nodules or minor pneumonia, through chest CT scans [1]. These methods encompass various approaches, including the utilization of maximum intensity projection (MIP) images, which involve internal target volumes (ITVs) of gross tumor volumes (GTVs) to analyze minute lung lesions or nodules [2]. Given the ongoing global infectious situations, chest CT scans have gained even greater significance in medical practice [3]. Leveraging a combination of CT scan measures can significantly enhance clinical assessment and treatment outcomes [4].

The authors and their colleagues have extensive experience in medical practice and research spanning various areas, including diabetes, integrative medicine (IM), primary care (PC), and others [5,6]. Notably, respiratory issues have garnered significant attention due to the worldwide impact of COVID-19 [7]. Consequently, we have applied chest X-rays and CT scans to a range of pulmonary conditions [8].

In the course of our clinical experiences, we

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encountered an exceptional female patient who had reached the impressive age of one hundred years. Although she had been relatively free from significant health issues, she developed a mild respiratory problem in May 2023. This report aims to provide an overview of her general medical journey and associated perspectives.

Case Presentation

Medical History:

The patient is a 102-year-old female with a history of hypertension. She has maintained her regular daily routine for many years. Her medical records indicate a relatively modest presence of atherosclerotic cardiovascular disease (ASCVD). Her prescribed medications include Amlodipine, atorvastatin, and azosemide. Occasionally, when she experiences insomnia, she uses suvorexant. Due to her advanced age of over 100 years, her renal function, as indicated by her eGFR, has exhibited a somewhat lower level. She occasionally reports experiencing low back pain (LBP) and manages it with loxoprofen poultices. Aside from these concerns, she has not presented any significant medical or health issues thus far.

Throughout the period spanning January to November 2022, there were no notable changes or medical complications. In December 2022, she began to notice cold sensations in her bilateral hand fingers and subsequently initiated tocopherol (vitamin E) supplementation. For the winter period of 2022-2023, her medical status remained uneventful. She has received a total of six COVID-19 vaccinations. However, in late May 2023, she developed symptoms including a sore throat, cough, sputum production, and fever.

Physical and Other Exams:

In May 2023, her physical examination revealed the following findings: her level of consciousness and speech were both normal. Vital signs were within acceptable ranges, with a SpO$_2$ of 97%. No abnormalities were detected in the head, neck, or heart. Slight rough lung sounds were noted bilaterally. Her abdomen and neurological assessment yielded intact results. In terms of physique, her measurements were as follows: height of 141 cm, body weight of 38.4 kg, and a BMI of 19.3 kg/m^2.

She underwent both blood tests and radiological exams. The results of the blood test were as follows: Hb (hemoglobin) 12.3 g/dL, RBC (red blood cell count) 420 x 10^6 /μL, WBC (white blood cell count) 7800 /μL, Plt (platelet count) 26.9 x 10^4 /μL, Cre (creatinine) 1.13 mg/dL, BUN (blood urea nitrogen) 26 mg/dL, AST (aspartate aminotransferase) 13 U/L, and ALT (alanine aminotransferase) 13 U/L. The blood chemistry analysis yielded unremarkable results for this centenarian subject.

Upon performing a chest X-ray, a potential consolidation in the left middle lung was identified (**Fig-1**). Subsequently, a standard chest CT scan displayed a slight consolidation shadow in the posterior region of the left middle lung (**Fig-2**). Notably, this particular image utilized a width of 1mm for each 1mm interval. In contrast, **Fig-3** illustrates the maximum intensity projections (MIP), employing a 3mm width for the tomography with a slab thickness of 20mm. A comprehensive assessment of all the findings from figures 1, 2, and 3 enables the precise observation of changes in lung consolidation.
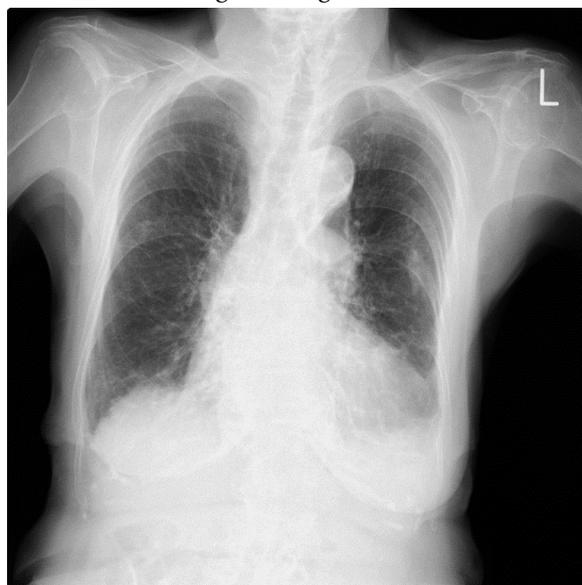

Fig-1: Chest X-Ray in Patient with 102 Years Old

Clinical Progress:

Based on the information provided earlier, the patient was diagnosed with a mild case of bronchopneumonia affecting the left lung. The prescribed treatment involved a daily dose of

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Levofloxacin 500mg for a duration of 5 days. The patient's clinical condition exhibited improvement following the administration of antibiotics, and no significant adverse effects were observed.

Ethical Standards

This report adheres to the ethical guidelines outlined in the Declaration of Helsinki. Additionally, measures have been taken to ensure the protection of personal information in accordance with regulatory standards. The principles governing this research align with ethical norms for clinical studies involving human subjects. Specific guidelines established by the Japanese government, including the Ministry of Education, Culture, Sports, Science and Technology, and the Ministry of Health, Labor, and Welfare, have been followed.

The authors and their colleagues have established an ethical committee at Kanaiso Hospital in Komatsushima, Tokushima, Japan, to oversee matters related to this case. This committee comprises various
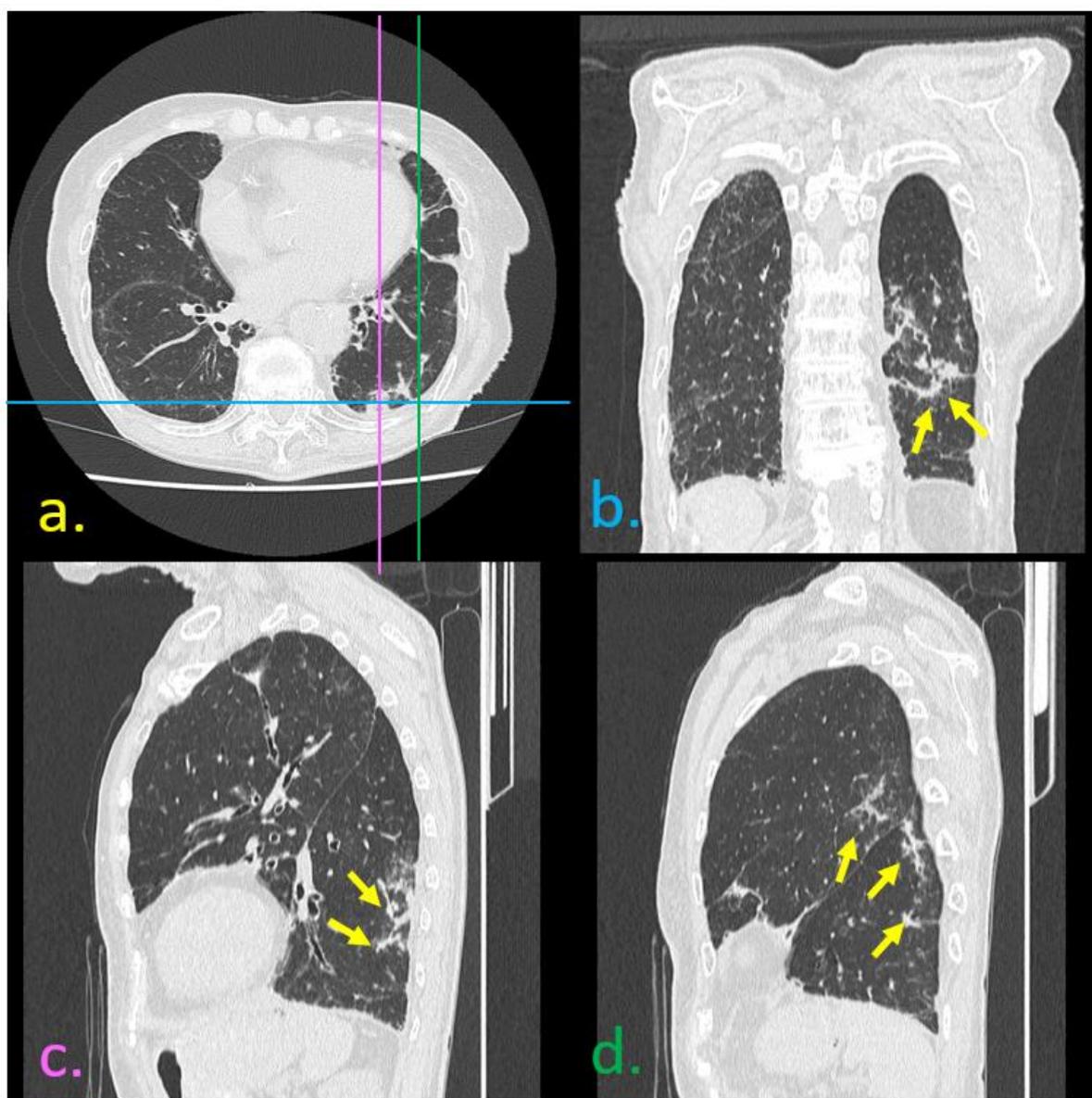

Fig-2: Lung CT Scan with 1mm Slice for 1mm Interval
2a: transverse view showed left lung with 3 aspects
2b: coronal view showed lesion in middle lung
2c: lateral view showed lesion in lower dorsal lung
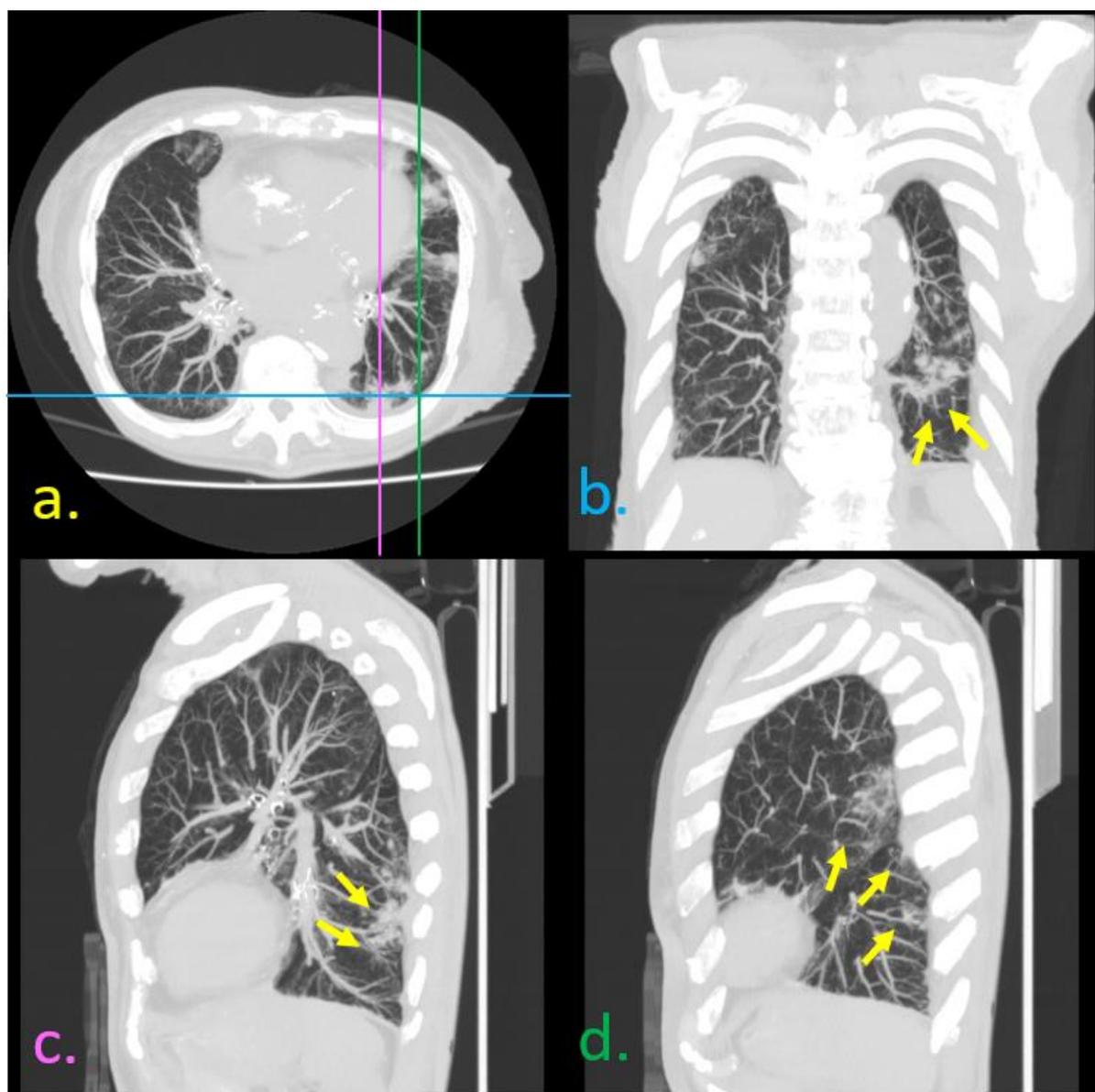2d: lateral view showed lesion in middle dorsal lung

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Fig-3: MIP CT with 3mm Slice and 20mm Slab Thickness
3a: transverse view showed left lung with 3 aspects
3b: coronal view showed lesion in middle lung
3c: lateral view showed lesion in lower dorsal lung
3d: lateral view showed lesion in middle dorsal lung

professionals, including the hospital president, physicians, radiologist, nurse, and pharmacist. Thorough discussions were held to formulate the research protocol, and unanimous agreement was reached. Informed consent was obtained from the patient through documented means.

Discussion

This case presents several noteworthy observations. Radiological evaluation utilizing the MIP method proved effective in this scenario. The combination of 2-D images from anterior and lateral views was found to be a beneficial approach, as demonstrated by the analysis of 562 data points [1]. In the realm of lung nodule detection, bi-directional MIP images were explored, employing various thicknesses such as 3mm, 5mm, and 10mm [9]. An innovative approach involving a three-dimensional patch of 10 adjacent slices was employed in the Multi-Encoders Network (MEDS-Net), achieving a remarkable 91.5% sensitivity in lung nodule detection through bi-directional MIP.

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The evolution of technology has ushered in the availability of multi-detector CT (MDCT) scanners for diagnosing lung nodules [10]. This advancement has led to the development of automatic and manual analysis methods. Comparing various processing techniques, MIP demonstrated superior results over Virtual Reality (VR) for pulmonary nodule detection in the study's 236 cases. Specifically, the 10-mm MIP showed notable superiority in detecting lung nodules.

In the pursuit of enhancing pulmonary nodule detection, deep learning-based computer-aided detection (DL-CAD) systems have investigated slab thickness variations [11]. The study encompassed 1186 nodules across 888 CT scans, analyzing MIP images with slab thicknesses ranging from 5mm to 50mm and 3mm to 13mm. Remarkably, the 10mm slab thickness yielded a sensitivity of 90%, underscoring the potential of multi-MIP images to improve lung nodule detection. Additionally, the study assessed the efficacy of different slab thicknesses for detecting solid nodules (SNs) and subsolid nodules (SSNs) through MIP and minimum intensity projection (Min-IP) images [12]. The results indicated that 10mm-MIP and 3mm-MinIP could be instrumental in SN and SSN detection, rivaling the capabilities of 1-mm axial images.

The centenarian female in this case study, a Japanese individual with no significant health issues, exemplifies the impact of factors such as adequate nutrition, robust immunological capacity, and cardiovascular health in maintaining wellness through the aging process [13]. The interplay between aging, dysbiosis, and alterations in the gut-lung axis function is noteworthy [14], contributing to her enduring health.

Nonetheless, certain limitations are inherent in this report. Although she had enjoyed good health until 2022, her development of slight bronchopneumonia in the summer of 2023 raises questions about potential exacerbating factors. While specific causative factors are not readily apparent, diligent clinical follow-up will be necessary in the future.

In summary, this case study of a 102-year-old female with slight bronchopneumonia underscores the significance of lung CT scan with MIP. The insights provided here hold promise as a reference for respiratory infections and the effects of aging.

Conflict of Interest

The authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

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